PARADIGM SERVICES BY ASTRIUM

NOAA Space Weather Week 2012

Paradigm and Space Weather

Presented by
Brian Swinburne, Head of Flight Dynamics

23rd – 27th April 2012

All the space you need

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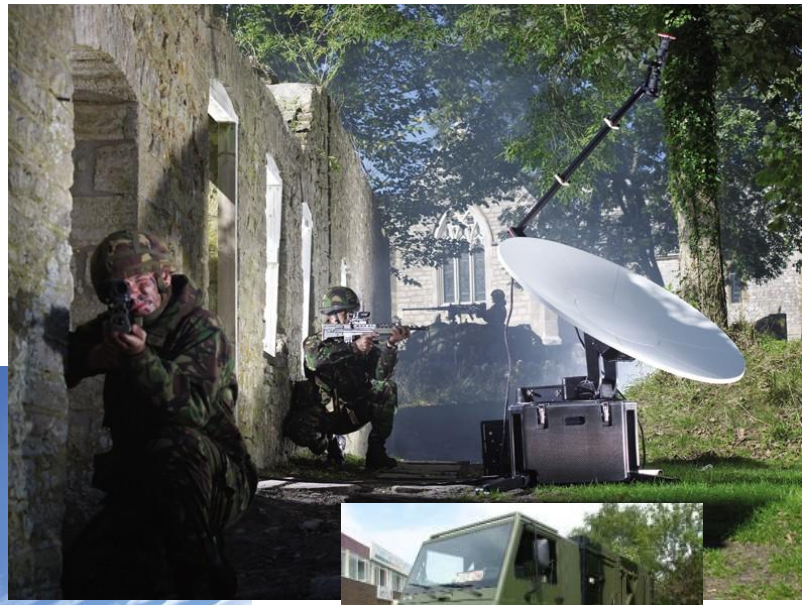
Paradigm

- Paradigm provides end-to-end, resilient secure communications services to the UK MoD and other third party users



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Paradigm Fleet

	Spacecraft	Launch Date	Status	
SKYNET 4/NATO IV	SKYNET 4B	11 Dec 1988	Mission Complete – Jun 1998	Stage 1
	SKYNET 4A	01 Jan 1990	Mission Complete – Jun 2005	
	SKYNET 4C	30 Aug 1990	Operational	
	NATO IVA	08 Jan 1991	Mission Complete – Aug 2007	
	NATO IVB	08 Dec 1993	Operational	
	SKYNET 4D	10 Jan 1998	Mission Complete – Jan 2008	Stage 2
	SKYNET 4E	26 Feb 1999	Operational	
	SKYNET 4F	07 Feb 2001	Operational	
SKYNET 5	SKYNET 5A	11 Mar 2007	Operational	S1
	SKYNET 5B	14 Nov 2007	Operational	
	SKYNET 5C	12 Jun 2008	Operational	
	SKYNET 5D	Q4 2012	Testing	S2

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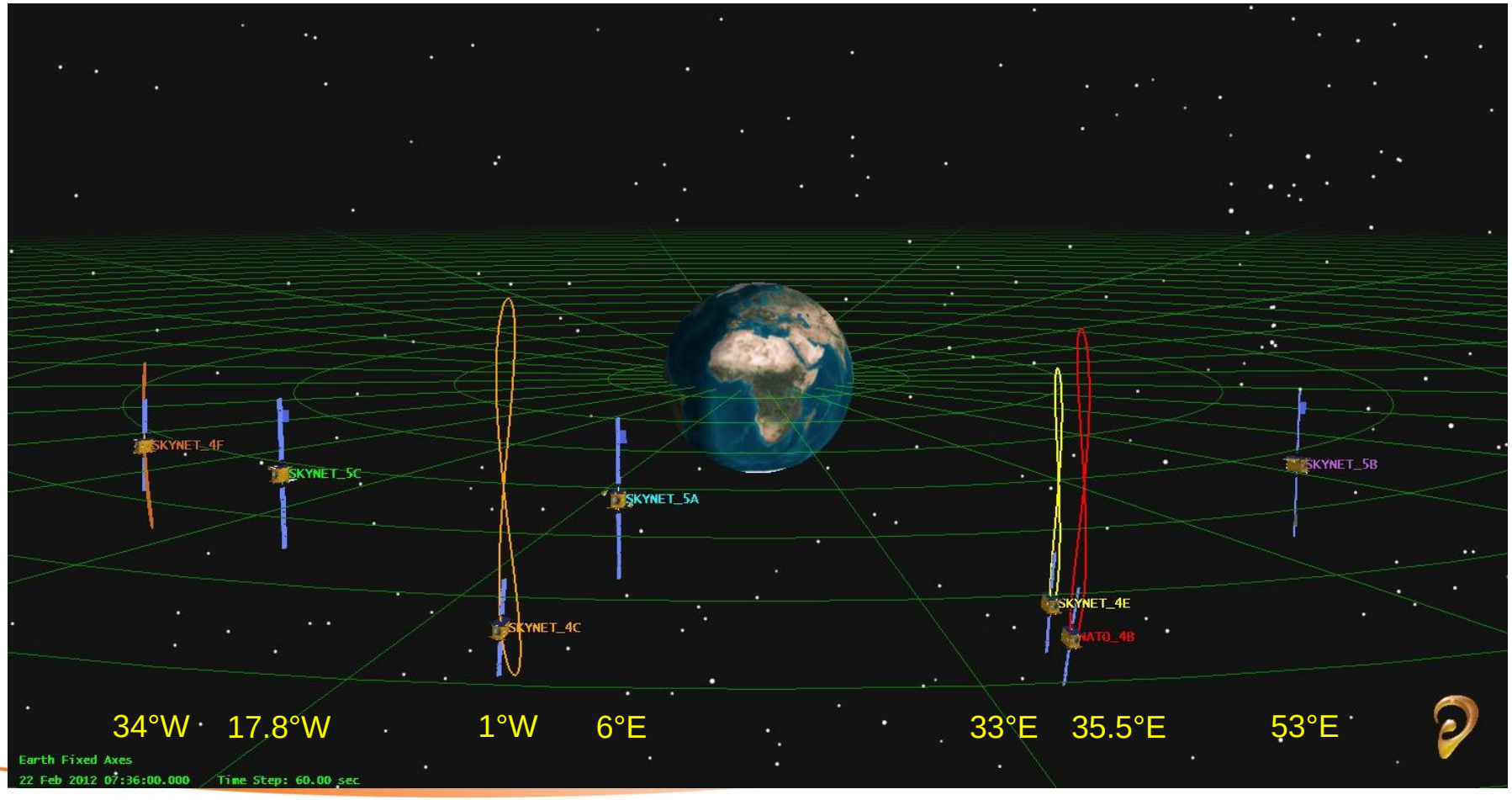
Paradigm Fleet



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Space Weather Effects

- Typical effects on spacecraft platforms
  - Single Event Effects
    - Memory register corruptions
  - Deep Dielectric Discharge
    - Electrical discharge into cables, harness and platform units
    - May cause damage or spurious switching
  - Displacement Damage
    - Degradation of Solar Arrays and sensors
  - Total Ionising Dose
    - Degradation of platform units over time

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SKYNET 5

- Hardened EUROSTAR 3000 platform
  - Single Event Upsets
    - On-board error detection and correction of memory register corruptions
  - Deep Dielectric Discharge
    - Designed out of system by choice or materials and shielding
  - Displacement Damage and Total Ionising Dose
    - Spacecraft designed to have margin over lifetime
- SKYNET 5 spacecraft have proven to be robust to space weather effects
  - No service interruptions to date

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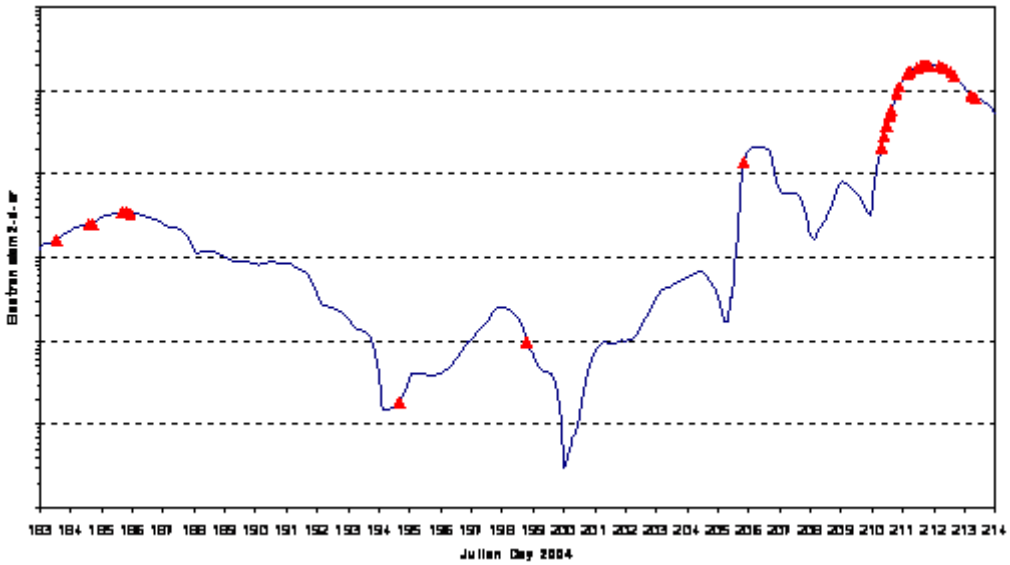
SKYNET 4

- Based on ECS Platform
  - Susceptible to high energy electrons (>2MeV)
    - Spurious switching and memory register corruptions
- Mitigation
  - Automated Ground Procedures
    - Monitor registers
    - Upload parameters upon corruption
  - Manual Procedures
    - Recovery from spurious switching events



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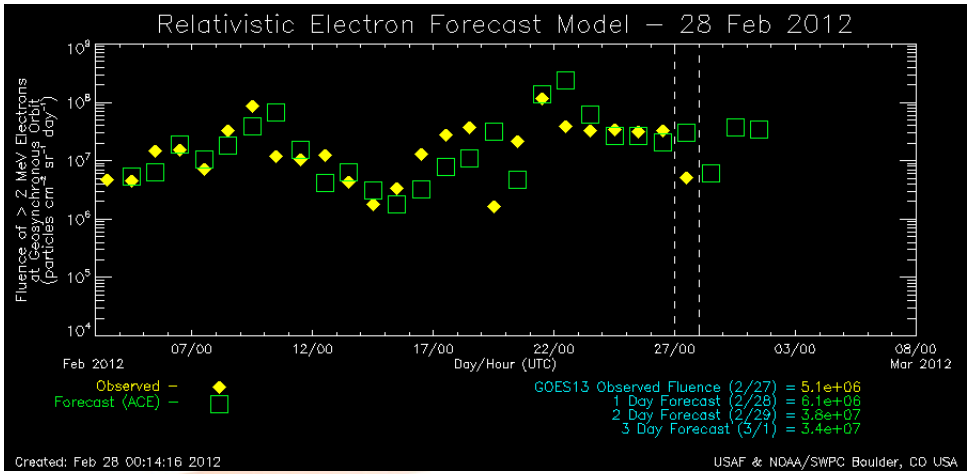
SKYNET 4

- Customer Warning Service
  - NOAA Nowcast and Forecast
    - Paradigm receives warnings from NOAA when electron flux level (2MeV) level rises above 1000 pfu
    - Paradigm monitors Relativistic Electron Forecast Model
    - Paradigm sends out a warning of risk of service interruption to PCCC and others if required
  - UK MoD Space Weather Warning
    - Not currently used for warning service



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Future

- Improved Space Weather Warnings
  - Value added service into Paradigm
    - Platform specific warnings
    - Severity of impact
    - Duration of event
    - Predictive rather than reactive service
- Further understanding of local space weather effects
  - Flying sensor packages
  - Correlation of platform events against weather forecast
  - Operators sharing/pooling information

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